

Before the
Federal Communications Commission
Washington, D.C. 20554

MM Docket No. 88-510

In the Matter of

Improved Methods for Calculating
Groundwave Field Strength in the
AM Broadcast Band

NOTICE OF PROPOSED RULE MAKING

Adopted: October 13, 1988; Released: November 10, 1988

By the Commission:

INTRODUCTION

1. The Commission is initiating this *Notice of Proposed Rule Making* to examine its Rules relating to groundwave propagation in the AM broadcast service. In particular, the Commission is considering replacing the existing groundwave propagation curves contained in the FCC Rules with groundwave propagation curves recently developed. The Commission believes that these new curves are more accurate and their use would provide a better depiction of groundwave service and interference in the AM broadcast band.

2. This proceeding is an outgrowth of the *Notice of Inquiry*, MM Docket No. 87-267, 52 FR 31795, August 24, 1987, (*Inquiry*) which provided a comprehensive review of the Commission's AM broadcast assignment criteria and related matters.¹ The goal of the *Inquiry* was to identify any changes to the Commission's Rules which would permit AM stations to improve their service to the public and enhance their ability to compete in the market place.

3. The Commission discussed a number of issues specifically related to the calculation of groundwave field strength in its *Inquiry*. In particular, one alternative discussed is to replace all of the current groundwave propagation curves in the FCC Rules with improved groundwave propagation curves recently developed by the Commission's staff. Several related matters were also discussed in the *Inquiry*, notably, the need to revise the current FCC ground conductivity map (Figure M3) and revision of the current FCC method used to calculate groundwave field strength over paths containing more than one conductivity value.

4. We recognize that changes to the Commission's Rules to reflect new procedures for calculating groundwave field strength may well have, among other things, an effect on the portrayal of existing service and interference as well as an effect upon future calculations related to new and modified AM facilities. However, we believe that consideration at this time of procedures providing improved accuracy would facilitate future consideration of other possible changes to the Commission's technical assignment criteria. This would provide accurate groundwave field strength calculations for use in assessing the interrelationships of

such proposed changes. Ultimately, improved accuracy in groundwave calculations would ensure that proposed new or modified AM stations would provide intended protection to other stations, or, conversely, that such proposed changes would not be unnecessarily restricted.

5. A substantial number of public comments which addressed groundwave propagation issues were received in response to the *Inquiry*.² These comments provide a general consensus supporting consideration of new methods for calculating groundwave field strength as suggested by the Commission in its *Inquiry*. For all of the reasons discussed, we believe that the time is now ripe for considering changes to the procedures for calculating groundwave field strength as proposed in the following sections.³ Before addressing these proposed changes, however, the following background information is provided.

BACKGROUND

6. In contrast to the other frequency bands where broadcast services are authorized, the propagation characteristics of the AM broadcast band vary with the time of day. During daytime hours, signal propagation of an AM station is predominantly by groundwave signals. Groundwave signals travel along the surface of the earth and are thus affected by the characteristics of ground conductivity along the propagation path.

7. During nighttime hours, however, skywave signals from an AM station reach distances many times greater than its groundwave signals. Skywave signals are reflected from the ionosphere and can be propagated many hundreds of miles from the transmitter location. Nighttime propagation has both positive and negative implications. On the one hand, nighttime skywave can be employed to provide skywave service many hundreds of miles from the transmitter, whereas, on the other hand, such enhanced conditions also increase the interference possibilities of co-channel stations over distances of hundreds of miles. As a consequence, co-channel stations that could be located reasonably close to one another without experiencing interference during daytime hours could cause significant mutual interference during nighttime hours.

8. A fundamental characteristic of groundwave propagation is that the signal radiated from an AM station is at a maximum at or near the transmitter site and diminishes in strength as the distance from the station increases. Groundwave field strength calculations are performed in accordance with Section 73.183 of the FCC Rules. These procedures make use of the groundwave propagation curves contained in Section 73.184 of the FCC Rules⁴ as well as FCC Figure M3 which portrays estimated effective ground conductivities throughout the United States.⁵ Procedures are also included for determining ground conductivity from field strength measurements which may be used in lieu of ground conductivity values obtained from Figure M3.

9. Significant advances were made in groundwave propagation theory in the late 1930s, and the FCC developed a full set of groundwave propagation graphs based upon that theory in 1939. These curves, which were prescribed by the FCC Rules until 1985, were drawn on the basis of exact mathematical computations for the field strength out to approximately 80 kilometers and also at much greater distances, typically beginning at approximately 320 km. It was necessary, however, to use freehand drawing to complete the curves at the intermediate distances because the

required computations for this region were too laborious to perform and the underlying mathematics was not fully established at that time. An additional very low conductivity curve was added to each of the original graphs in 1954. When these low conductivity curves were added, freehand drawing was still necessary to depict the field strength values at the intermediate distances.

10. In preparation for the Regional Administrative Radio Conference for AM broadcasting convened in 1980,⁶ a computer program was developed by the Commission for recalculating a new set of groundwave curves for consideration by the Conference. These new groundwave propagation curves were drawn in metric format and extended to 10,000 km.⁷ The field strength values derived from the new curves agreed to within one or two decibels with values from the curves in the FCC Rules. However, the computer program developed to produce the new curves did not overcome the difficulties previously encountered in calculating field strength values for intermediate distances since the mathematics involved still did not provide an adequate solution. Thus, it was necessary to force a match between the two portions of the curves where calculations were possible.

11. In implementing the Final Acts of the Region 2 Conference (1981), the Commission conducted a rule making proceeding for the purpose of aligning the domestic technical standards with those in international agreements.⁸ At the conclusion of the rule making, the Commission adopted the groundwave propagation curves for domestic use.⁹ Although in a different format, these curves were consistent with those adopted at the Conference.

12. The Commission staff continued its efforts to improve further the accuracy of the FCC groundwave curves. In February 1986, the Commission released a report, FCC/OET R86-1,¹⁰ which described a new computer program incorporating solutions to the previous mathematical deficiencies. Use of that computer program permitted precise field strength calculations to be performed at all distances, including the previously troublesome intermediate distances. The computer program was used to compute the groundwave curves for the band 1605-1705 kHz that were proposed by the United States to the First Session of the Conference¹¹ convened in 1986 to expand the AM broadcast band from 1605 to 1705 kHz.¹² This computer program is capable of calculating new groundwave curves for the band 535-1605 kHz.

DISCUSSION

13. The Commission has identified shortcomings in the current FCC groundwave field strength calculation procedures, the importance of which is magnified by the continuing demand for spectrum and growing concerns regarding interference as the AM broadcast band becomes more congested. Shortcomings in these procedures discussed in the *Inquiry* included: (1) the groundwave propagation curves, Graphs 1 to 19 of Section 73.184 of the FCC Rules, are not fully consistent with formulas in engineering texts; (2) the method described in the FCC Rules to adjust for a dielectric constant different from the standard value used in drawing the curves is not easily applied;¹³ (3) the ground conductivity map, Figure M3, does not accurately depict ground conductivity values throughout the United States; and (4) the FCC method

used to calculate groundwave field strength over paths containing more than one conductivity value is limited in its application.

14. Based upon the public comments received in the *Inquiry* and our own assessment of the issues raised in these matters, we are proposing new groundwave propagation curves derived from the 1986 computer program to replace the current curves in Section 73.184 of the FCC Rules. However, as discussed in detail *infra*, we are deferring consideration of the other issues related to groundwave calculation procedures.

15. *New Groundwave Propagation Curves.* The present FCC groundwave propagation curves appear to be sufficiently accurate over the ranges where precise calculations for their development were possible. However, there is a significant range of distances for these curves over which precise field strength calculations were not performed during their development. As a consequence, their use in certain instances results in an inaccurate portrayal of service and interference for AM broadcast stations.

16. For these reasons, in the *Inquiry* we discussed the desirability of developing new groundwave propagation curves to replace the curves currently in the FCC Rules. Comments filed in response to the *Inquiry* were overwhelmingly in favor of using the most advanced methods available for performing groundwave field strength calculations and recommended development of the revised curves. In their comments, the National Association of Broadcasters (NAB) and other parties urge the Commission to establish technical standards and calculation methods that would more accurately depict the service and interference in the AM broadcast band. CBS, Inc. (CBS) notes that where accurate determinations of interfering signals and protected contours are not available, interference may be caused where none was calculated, or the parameters of a station may be unnecessarily constrained. In addition, the Association for Broadcast Engineering Standards, Inc. (ABES) believes that it would be desirable to revise Graphs 1 to 19 to agree more closely with engineering formulas in order to simplify calculator or computer aided analyzing processes.¹⁴

17. Another matter discussed in the *Inquiry* concerns the conversion of Graph 20 of Section 73.184 of the FCC Rules from English to metric units. All commenters agreed that conversion to metric is desirable except for Schober who stated that the graph is unnecessary since the curves may be calculated directly by use of a computer.¹⁵

18. In view of the recommendations we received in the comments and the improved accuracy¹⁶ that would be derived from adoption of improved groundwave propagation curves, we propose amending the Rules to incorporate the use of new groundwave propagation curves which are based upon the report, FCC/OET86-1.¹⁷ Sample draft curves, reduced in size, are included in Appendix B of this *Notice*. A complete set of draft curves drawn to full scale is being placed in the record of this proceeding. In addition, we propose to convert Graph 20 to metric units in order to facilitate its use.¹⁸ Comments are invited on these proposed changes, and, in addition, the Commission will consider alternative proposals which may provide potential improvements related to calculating groundwave field strength in the AM broadcast service.

19. *Improvements to FCC Figure M3.* Since the development of FCC Figure M3 in 1954, substantial ground conductivity measurement data has been collected by the FCC as a result of field strength measurements related to con-

struction and testing of AM broadcast antenna systems. These measurements have demonstrated the inaccuracies of Figure M3.¹⁹ Section 73.183(c) of the Rules recognizes the limitations of Figure M3 and prescribes its use only when accurate and acceptable measurements have not been made.²⁰

20. An alternative discussed in the *Inquiry* was the possibility of using the groundwave field strength measurements on file with the FCC to revise Figure M3. The Commission also noted in the *Inquiry* that other government agencies have been performing tasks related to collection of groundwave conductivity data and questioned whether such data would be appropriate to use if Figure M3 were revised.²¹

21. There was unanimous support in the comments received in response to the *Inquiry* to undertake steps to improve the accuracy of the ground conductivity map, FCC Figure M3. The comments of CBS are typical. CBS agrees with the *Notice's* assessment of deficiencies in Figure M3 and believes the Commission should conduct a rule making to consider the issues surrounding revision and updating of Figure M3. According to CBS, it has long been known that Figure M3 is an imprecise guide and that inadequacies in the ground conductivity estimates taken from it limit the accuracy of calculations of AM groundwave propagation. In addition, CBS notes that the imprecision inherent in the present map unduly complicates and adds to the cost of AM engineering practice, as actual field strength measurements must be made in many instances where the Figure M3 conductivity value is unsuitable. On the matter of considering the use of ground conductivity data from other agencies, such as the FAA, the majority of the comments provided little support. Moreover, one commenter specifically opposed their use citing the fact that the FAA continues to employ FCC Figure M3 as the basis for its current frequency allocation studies.²²

22. One dominant and recurring theme appears in the comments on this matter. That is, commenters note the complexity of the task to compile a data base of groundwave field strength measurements and to revise FCC Figure M3. ABES, for example, urges the Commission to take the lead in a project which, because of its complexity and great cost, can only be effectively undertaken at the governmental level.²³ This view was shared by many other commenters as well.

23. We agree that improvement of Figure M3 is both a desirable and substantial undertaking. This issue was raised in the *Inquiry* to provide the opportunity to identify possible approaches for updating Figure M3 that would not exceed available resources both within the industry and the FCC. In view of the comments received on this matter, it appears that the only viable alternative for updating Figure M3 is for the FCC to undertake the task, possibly through a contract. The Commission agrees with the comments regarding the anticipated substantial costs of such a project. Currently, there are no funds available for such a project and, in view of budget restrictions, it is not anticipated that such funding would be available anytime in the near future. In view of this, we are deferring further consideration of this matter until funding becomes feasible.

24. *Calculations over mixed paths.* Section 73.183(e) of the FCC rules prescribes the procedure to be used when calculating groundwave field strength over paths containing more than one conductivity value (mixed paths). This

is referred to as the equivalent distance method or "Kirke method" after H. L. Kirke who described several calculation methodologies and compared results of calculations with actual measurements in 1949. Predictions by the Kirke method are known to be imperfect and we explored alternative procedures in the *Inquiry*.²⁴

25. The comments on this subject were mixed. Most commenters suggested the continued use of the "Kirke" method while some recommended consideration of other methods. None, however, identified any other method which would be a worthwhile improvement. AFCCE finds the "Kirke Method" acceptable and it does not foresee that a change in methodology would result in a substantial increase in accuracy in the prediction of groundwave field strength contours whether for service or for interference situations. Robert A. Jones notes that the present method has served the AM broadcast service well over the years and suggests no change. After considering the comments, we have concluded that it would not be useful to attempt to improve on the Kirke method at this time. Commenters in this proceeding who have specific proposals to offer or definitive studies on this subject are invited to submit such material for our further consideration.

OTHER MATTERS

26. A general matter was raised by several commenters concerning implementation of new groundwave propagation curves and the relationship of this issue with other technical assignment criteria. WGN Continental Broadcasting Company (WGN), for example, believes that the issues surrounding groundwave propagation are so closely related to the allocations issues to be addressed later by the Commission that consideration of them at this point is premature. WGN, thus, requests the Commission to defer changes in the groundwave propagation rules until a review of the related allocations issues has been concluded. The Clear Channel Broadcasting Service (CCBS) urges the Commission to proceed with caution in developing new standards because of concerns about the possible disruptions of service that could result with such changes.

27. As we discussed *supra*, we are cognizant of the relationship between the groundwave propagation curves which we are considering in this *Notice* and other assignment criteria that may be considered in future rule making proceedings. We noted in the *Inquiry* that use of new technical standards could result in changes to the location of service contours and calculated levels of interference. We do not believe, however, that this fact should restrict us from proceeding with rule making at this time in order to develop a record on this issue. Such a record will guide the Commission on appropriate actions which ultimately should be taken.

28. We also believe, however, that there may be practical reasons for considering a delay in implementing new groundwave propagation curves, if adopted, until consideration of other possible changes to interrelated technical assignment criteria is concluded. Rather than implementing various changes to the technical assignment criteria in a "piece meal" fashion, we believe that there is merit in considering implementing simultaneously all the interrelated changes that may ultimately be adopted. We believe that this approach would minimize administrative burdens for the Commission as well as uncertainties within the industry. We seek comment on the advisability of such an approach.

29. It would not be our intent to require any modifications of existing AM broadcast facilities as a result of the changes proposed in this *Notice*; nor would we intend to require parties whose applications are pending at the time any proposed rule changes are implemented to amend their application.

ADMINISTRATIVE MATTERS

30. Authority for the rule changes on which comments are invited is contained in Sections 4(i), 303, and 307 of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 303, and 307.

31. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **January 3, 1989** and reply comments on or before **January 18, 1989**. All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and five copies of all comments, reply comments and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original and nine copies must be filed. Comments and reply comments should be sent to the Office of the Secretary, Federal Communications Commission, Washington, D.C. 20554. Comments and reply comments will be available for public inspection during regular business hours in the Dockets Reference (Rm. 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554.

32. For the purposes of this non-restricted notice and comment rule making proceeding, members of the public are advised that *ex parte* presentations are permitted except during the Sunshine Agenda period. *See generally* Section 1.1206(a). The Sunshine Agenda period is the period of time which commences with the release of a public notice that a matter has been placed on the Sunshine Agenda and terminates when the Commission (1) releases the text of a decision or order in the matter; (2) issues a public notice stating that the matter has been deleted from the Sunshine Agenda; or (3) issues a public notice stating that the matter has been returned to the staff for further consideration, whichever occurs first. Section 1.1202(f). During the Sunshine Agenda period, no presentations, *ex parte* or otherwise, are permitted unless specifically requested by the Commission or staff for the clarification or adduction of evidence or the resolution of issues in the proceeding. Section 1.1203.

33. In general, an *ex parte* presentation is any presentation directed to the merits or outcome of the proceeding made to decision-making personnel which (1) if written, is not served on the parties to the proceeding, or (2), if oral, is made without advance notice to the parties to the proceeding and without opportunity for them to be present. Section 1.1201(b). Any person who submits a written *ex parte* presentation must provide on the same day it is submitted a copy of same to the Commission's Secretary for inclusion in the public record. Any person who makes an oral *ex parte* presentation that presents data or arguments not already reflected in that person's previously-filed written comments, memoranda, or filings in the proceeding must provide on the day of the oral presentation a written memorandum to the Secretary (with a copy to the Commissioner or staff member involved) which summarizes the data and arguments. Each

ex parte presentation described above must state on its face that the Secretary has been served, and must also state by docket number the proceeding to which it relates. Section 1.1206.

34. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an initial regulatory flexibility analysis (IRFA) of the expected impact of these proposed policies and rules on small entities. The IRFA is attached as Appendix A. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the *Notice*, but they must have a separate and distinct heading designating them as responses to the Regulatory Flexibility Analysis. The Secretary shall cause a copy of this *Notice of Proposed Rule Making*, including the Regulatory Flexibility Analysis, to be sent to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act, Pub. L. 96-354, 94 Stat. 1164, 5 U.S.C. 601 *et seq.*, (1981).

35. The proposal contained herein has been analyzed with respect to the Paperwork Reduction Act of 1980 and found to contain no new or modified form, information collection and/or record keeping, labeling, disclosure, or record retention requirements, and will not increase burdens hours imposed on the public.

36. For further information on this proceeding, contact Larry W. Olson, Mass Media Bureau, (202) 632-6955.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

REGULATORY FLEXIBILITY ACT INITIAL ANALYSIS

I. Reason for Action:

In this proceeding, we seek public comment on the desirability of replacing the existing AM broadcast groundwave propagation curves with a new propagation model recently developed. The new model results from recent scientific analysis of groundwave measurement data and theory that provides a better understanding of groundwave propagation phenomena. Use of the new method for calculating groundwave field strength in the AM service would provide a more accurate depiction of the service and interference relationships between AM stations.

II. Objective:

The proposed changes are intended to modify provisions of the Rules which have been found to be inaccurate. This is in keeping with the Commission's efforts to update and improve the standards upon which the AM service is based so as to reflect the actual representation of service and interference.

III. Legal Basis:

Sections 4(i), 303 and 307 of the Communications Act of 1934, as amended, 47 U.S.C. §§154(i), 303, and 307.

IV. Description, Potential Impact and Number of Small Entities Affected:

There are approximately 5000 AM broadcast stations in the United States. None of these stations should be affected directly by this proposal since the changes proposed only relate to the standards (curves and formulas) used to calculate groundwave field strength. We expect no negative impact to these stations, small entities or large, as we are not mandating any new requirements or showings. Actual interference is not expected to increase as a result of the specific changes proposed in this *Notice*. We will, however, consider in future rule making proceedings the related questions regarding assignment principles which, together with the propagation model, may result in new definitions of service and interference for AM broadcast stations. Such definitions are not now known but are intended to be beneficial to the AM service as a whole.

V. Reporting Record Keeping, and other Compliance requirements:

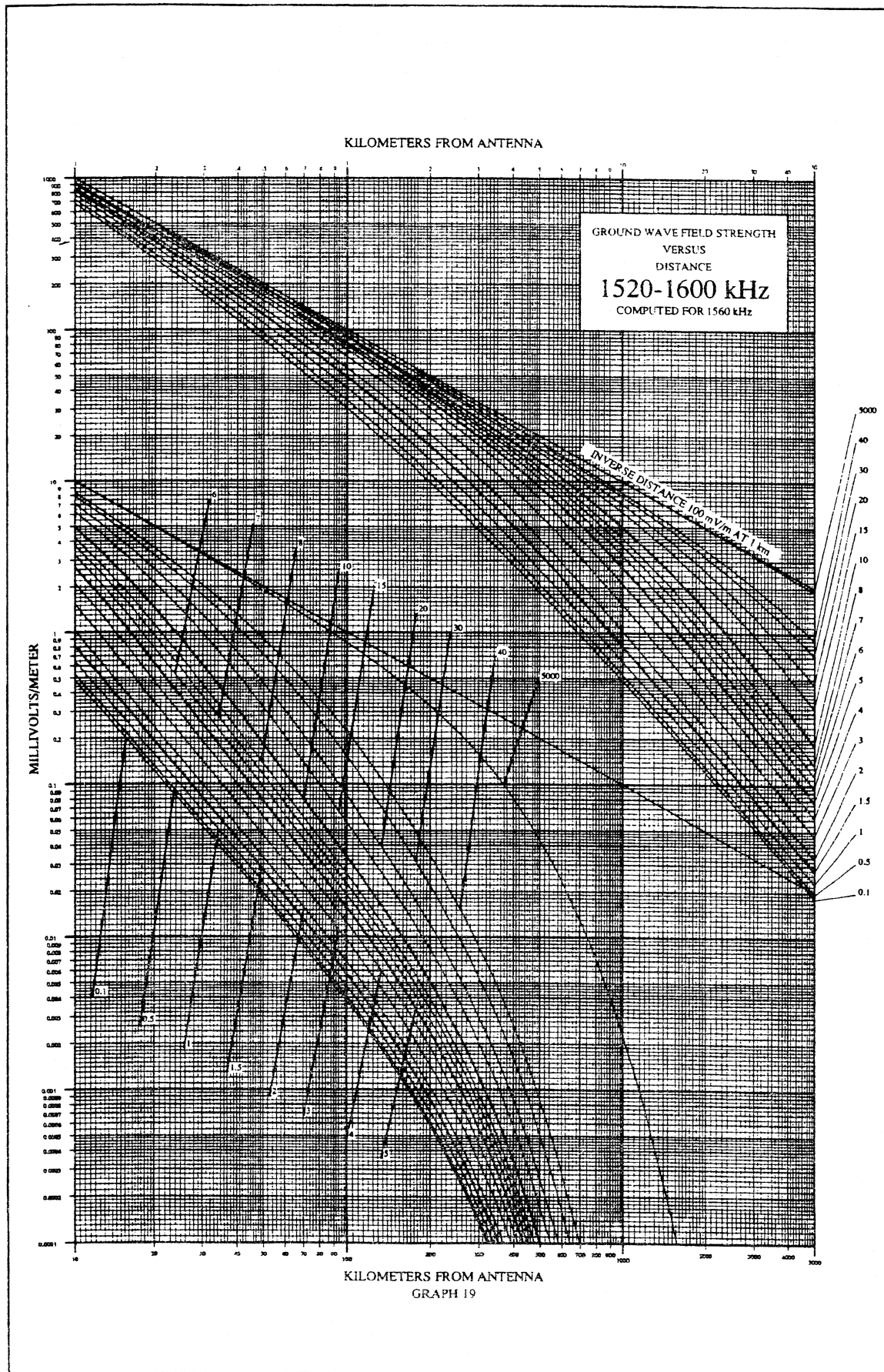
There is no additional impact.

VI. Federal Rules that Overlap, Duplicate or Conflict with These Rules:

There is no overlap, duplication, or conflict.

VII. Any Significant Alternatives Minimizing Impact on Small Entities and Consistent with Stated Objectives:

There are no significant alternatives available.



FOOTNOTES

¹ The *Inquiry* was issued after review of the comments received in response to the Mass Media Bureau's *Report on the Status of the AM Broadcast Rules*, RM-5532, (*Report*) released April 3, 1986. The *Report* discussed the status of AM broadcasting and addressed a large number of technical, legal, and policy issues.

² By *Order*, DA 87-1823, released December 15, 1987, the Commission granted a "Motion for Extension of Time for Filing Comments and Reply Comments" submitted by the National Association of Broadcasters (NAB). In that *Order*, the Commission bifurcated the proceeding and established separate filing periods. Phase 1 involved Sections II and III of the *Inquiry* while Phase 2 involved Sections I and IV. For the specific issues raised in Section III (Related Technical Issues) of the *Inquiry* under which groundwave propagation falls, the time for filing comments and replies was extended to February 1, 1988 and March 1, 1988, respectively.

³ This proceeding will examine only those issues pertaining to groundwave propagation. Where appropriate, the Commission will institute future rule making proceedings to deal with the remaining issues addressed in the *Inquiry* and public comments. For example, in a similar action today, the Commission instituted a proceeding concerning skywave propagation. See, *Notice of Proposed Rule Making*, MM Docket No. 88-508, FCC 88-324.

⁴ Graphs 1 to 19 are plotted for various AM broadcast frequencies and describe groundwave field strength as a function of the distance from the transmitter. Generally, for a given station the groundwave field strength at a specified distance is a function of the frequency and the earth's conductivity along the propagation path (*i.e.*, it varies inversely with frequency and directly with ground conductivity).

⁵ FCC Figure M3 was developed more than thirty years ago by correlating field strength measurement data with identified soil types. This process resulted in a very generalized depiction of ground conductivity in the United States with broad areas on the map delineated by individual conductivity values.

⁶ Regional Administrative MF Broadcasting Conference (Region 2). First Session, Buenos Aires, 1980; Second Session, Rio de Janeiro, 1981.

⁷ These curves were later adopted by the Conference.

⁸ At that time, negotiations on new bilateral agreements with Canada and Mexico either had been completed or were nearing completion. In both cases, negotiations were conducted with the view to incorporating the groundwave propagation curves adopted at the Rio Conference (1981).

⁹ FCC MM Docket No. 84-752, Report and Order "In the Matter of Changes in AM Technical Rules to Reflect New International Agreements," published in the *Federal Register* May 2, 1985 (50 FR 18818). The computer program used for calculating these curves was subsequently released to the public for use in lieu of curves for calculating groundwave field strength.

¹⁰ R. P. Eckert, "Modern Methods for Calculating Ground-wave Field Strength over a Smooth Spherical Earth", Report FCC/OET R86-1, February 1986.

¹¹ Regional Administrative Radio Conference to Establish a Plan for the Broadcasting Service in the Band 1605-1705 kHz in Region 2. First Session, Geneva, 1986; Second Session, Rio de Janeiro, 1988.

¹² These groundwave propagation curves were adopted by the Conference.

¹³ Graph 20 of Section 73.184, of the Rules, "Ground Wave Field Intensity versus Numerical Distance of a Plane Earth," is provided for this purpose. However, it is in English units (miles)

and therefore unwieldy since the related curves are in metric units (kilometers). The computer programs released in MM Docket No. 84-752 may be used in lieu of Graph 20.

¹⁴ Two commenters addressed the international implications. Edward A. Schober (Schober) stated that these graphs should have been included in the international negotiations with Mexico and Canada; and, unless the agreements can be modified to include the revised graphs, the current graphs should be retained. Karl D. Lahm (Lahm) believes that the Commission should encourage other Region 2 administrations, particularly Canada and Mexico, to do the same in order to maintain consistent technical methods for all allocation purposes. Our intent at this time would be to use the new graphs, if adopted, for domestic purposes. If the new groundwave curves are adopted, we would explore with Canada and Mexico the possibility of incorporating their use in our bilateral agreements.

¹⁵ Although not addressed in the *Inquiry*, Lahm suggested a change in the horizontal scale of the printed graphs and the density of the grid in order to facilitate curve reading and measurement analysis. A number of reply comments supported Lahm's suggestion.

¹⁶ As an example of the differences between the current FCC groundwave curves and those we are proposing, Commission studies show that for a frequency of 1000 kHz and a conductivity of 10 mmhos/m the groundwave field strengths derived from the proposed curves at distance ranges of 0-80, 80-320, and 320-4220 km are at most 0.5, 1.5, and 6.6 dB lower, respectively, than those derived from the current curves.

¹⁷ For reference, we are placing a copy of this report in the record of this proceeding. The computer program reproduced in the report could also be used for calculating groundwave field strength in lieu of the printed curves. Comments are solicited on the format of the draft curves.

¹⁸ The computer program described in Report FCC/OET86-1 can be employed in lieu of Graph 20.

¹⁹ On December 15, 1980, the FCC released a *Notice of Inquiry* in BC Docket No. 80-757, In the Matter of Amendment of the Rules concerning Automation of the use of Measurement Data for AM Broadcast Stations. This proceeding solicited comments concerning development of a data base comprising all outstanding measurement data submitted to the FCC for AM assignment studies. A consideration included was development of a digitized conductivity map based on the measurement data.

²⁰ Also, Figure M3 does not include conductivity information for Alaska, Hawaii, or United States territories.

²¹ The Federal Aviation Administration (FAA) also has collected ground conductivity data relevant to aeronautical beacons in the band 200-415 kHz and maps have been produced with more detail in some areas of the United States than FCC Figure M3. See, S. A. Arcone and A. J. Delaney, "Electrical Ground Impedance Measurements in the U.S. between 200 and 415 kHz", Report No. FAA-RD-78-103, 1978.

²² See, September 8, 1987, edition of the FAA's "Spectrum Management Regulations and Procedures Manual" (6050.32), Figure 11-2 (page 103).

²³ In noting that all commenters favored the updating of the ground conductivity map, ABES states that the problem with the revision of the ground conductivity map is finding someone who, in these days of austerity, can absorb the costs of such an enormous undertaking. As stated in its comments, ABES believes that the federal government is the only entity with the capacity of completing that task and urges the Commission to approach the Office of Management and Budget, the Congress and the National Telecommunications and Information Administration for the funds and facilities required.

²⁴ One of the alternative methods discussed was the "Millington" method. *See*, G. Millington, "Ground Wave Propagation over an Inhomogeneous Smooth Earth", *Proc. of the Institution of Electrical Engineers (London)*, Part III, Vol. 96, pp. 53-64, January 1949; H. L. Kirke, "Calculation of Ground-wave Field Strength over a Composite Land and Sea path", *Proceedings of the IRE*, Vol. 37, May 1949, pp. 489-496; J. R. Wait, "Recent Analytical Investigations of Electromagnetic Ground Wave Propagation over Inhomogeneous Earth Models", *Proceedings of the IEEE*, Vol. 62, pp. 1061-1072, August 1974.